REMARKS

Claims 1-8 were pending in this application. With this amendment, the applicant has cancelled claims 1-8 and added new claims 9-33, which are now the pending claims in this application.

Claims 1 and 5 were objected to because of informalities. When rewriting the claims, these objections were kept in mind such that the new claims, including claims 10, 11, 22, and 23, would not raise the same objection.

Claims 1-8 were rejected under 35 U.S.C. § 112, first paragraph, as failing to enable one skilled in the art how to make and/or use the claimed invention. Specifically, the Office Action noted that the invention was claimed in terms of a desirable conversion efficiency, but recited no indication of how these desirable properties may be obtained. In response, the applicant has amended the claims to provide such an indication in independent claims 9 and 21. As the Office Action recognizes, the low loading of the platinum in the lean NOx catalyst is a key component of the invention, and a specific maximum loading, 30g/ft^3, has been included in claims 9 and 21. Support for this amendment is found in the specification at, for example, page 2, lines 19-28. There, the specification notes, "We have discovered that reducing the loading of catalytically active component ... serves to increase the selectivity of the catalyst towards NOx reduction." Page 2, lines 23-26. Moreover, another feature important to the invention is the order of placement of the catalysts (or process steps), and this feature is also included in the claims. Therefore, it is believed that the specification properly teaches one skilled in the art how to make and use the invention as recited by the newly added claims.

Support for all claims is found in the specification and, for convenience, the applicant refers below to specific (but not necessarily the only) citations in the specification providing support for each of the newly added claims. Support for claims 9 and 21 is found at page 1, lines 18-29, page 2, lines 19-28, and in Example 1, note (5). Support for claims 10, 11, 22, and 23 is found at page 1, line 31 through page 2, line 8. The subject matter of claims 12 and 24 is described page 2, line 22, and the subject matter of claims 13 and 25 is found at page 3, line 9. Claims 14 and 26 recite the same subject matter as claim 4.

Support for claims 15 and 27 is found in Example 1, page 7, line 20. Support for claims 16 and 28 is found at page 2, line 22 and page 3, line 18. Claim 29 is analogous to claim 6, and claim 30 is analogous to claim 7. Claims 17 and 30 are supported by the comment at page 3, line 1 and comparing the lengths in Example 1 of the catalyst of the invention (9 inches) with that of the OEM catalyst (6 inches). Claims 18 and 31 are supported at page 3, line 2, and claims 19 and 32 are found at page 4, lines 4-7. Finally, claims 20 and 33 are found in the specification at page 4, lines 17 and 18, and this citation also shows that the inventor contemplated an engine, as is now being claimed by claims 9-20.

Claims 1-8 were rejected under 35 U.S.C. § 112, second paragraph, as indefinite. All of the points raised in the Office Action were considered by the applicant when drafting newly added claims 9-33. Many of the objectionable claim terms have been removed or edited to overcome this rejection. The applicant notes specifically that claims 10, 11, 22, and 23 still recite the language, "a hydrocarbon:NOx input ratio of 3:1 counting the hydrocarbon as equivalent propane." The reference to "the hydrocarbon" is referring to the hydrocarbon term introduced by the recited ratio. Moreover, the phrase "counting the hydrocarbon as equivalent propane" is believed to be sufficiently definite in that it is more precisely specifying what the hydrocarbon:NOx ratio is. Thus, this terminology is believed to comply with Section 112, second paragraph. With the revisions presented by newly added claims 9-33, the applicant requests withdrawal of this rejection.

Claims 1-8 were rejected under 35 U.S.C. § 103(a) as being unpatentable over US Patent No. 4,071,600 to Schlatter et al. For the reasons discussed below, and in view of the attached declaration, the applicant contends that this should not be a basis for rejection of claims 9-33.

The invention set forth by claims 9 and 21 is concerned with improving nitrogen oxide (NOx) conversion in an emission control system of a lean burn engine. The engine recited by claim 9 includes an emission system comprising a lean NOx catalyst comprising less than 30 g/ft^3 platinum for reducing NOx to N_2 and an oxidation catalyst, downstream of the lean NOx catalyst, comprising a platinum group metal (PGM) for oxidizing hydrocarbons and carbon

monoxide. The process set forth by claim 21 is for controlling emissions from a lean-burn internal combustion engine and recites passing exhaust gases first over the lean NOx catalyst, then over the oxidation catalyst. Thus, the claimed invention captures not only the use of platinum as the choice for lean NOx catalysis of NO on the lean side, but doing so at a low loading of the platinum, and before the gas is exposed to a catalyst for oxidizing hydrocarbons and carbon monoxide. Neither Schlatter nor Chen (also cited, as discussed below) discloses or suggests this invention.

First of all, Schlatter et al. does not describe a lean burn engine. Instead it describes a stoichiometrically-operated gasoline engine (see column 1, lines 39-60) also evidenced by the relatively low % of oxygen used in the synthetic exhaust gases of the Examples (see column 8, line 5) compared with lean burn exhaust gases (see below). Additionally, the upstream catalyst is not a platinum (Pt) lean NOx catalyst (LNC), but a rhodium (Rh) LNC.

Schlatter is concerned with *inter alia* improving nitric oxide (NO) control on the lean side of the stoichiometric point (see column 1, lines 39-60). Schlatter et al acknowledge that at the time of their invention it was known that rhodium was effective for catalyzing the reduction of NO (see column 1, lines 16-18). In seeking to develop a system for improved three-way emissions control which gave improved NO control, Schlatter et al concluded that catalysts with higher oxidation activities - such as Pt and palladium (Pd) - were less efficient for converting NO on the lean side (see column 6, lines 27-34). Furthermore, Schlatter states that "Rhodium's primary function is to selectively reduce NO to N_2 by reaction with CO, H_2 or HC [i.e. lean NOx catalysis]. This is enhanced by high concentrations of the reducing agents. Platinum's role is to eliminate the reducing agents (CO, H_2, HC) by reacting them with oxygen. This is in conflict with the role of Rh" (see column 6, line 41-47).

Schlatter also emphasizes the importance, in its view, of placing a rhodium catalyst *upstream* of a platinum catalyst, unlike the claimed invention. See column 2, lines 18-22 (stating "placement of these catalyst materials [platinum/palladium] downstream of the rhodium assures improved nitric oxide control") and column 7, lines 3-6. Nonetheless, even if a Pt catalyst bed were to be

disposed upstream of the Rh catalyst bed, Schlatter teaches that, fresh or aged, the system was less effective in treating NO on the lean side. See the comparison at Figures 7 and 8 and column 6, line 61-column 7, line 14 and column 8, lines 12-26.

In view of the above, one of ordinary skill in the art would conclude from Schlatter that Rh is the platinum group metal (PGM) of choice for lean NOx catalysis of NO on the lean side. Furthermore, if the price of Rh were to fall below the price of Pd and Pt, and its availability was improved, a three way catalyst could contain Rh as the sole PGM (see column 1, lines 33-39 and column 4, lines 28-37).

A lean burn engine according to the present invention can be a diesel engine or a lean burn gasoline engine, such as a direct injection gasoline engine. Exhaust gas from the stoichiometrically-operated engine of Schlatter may have an oxygen concentration of up to about 1.0% on the lean side (see Schlatter, Figures 1, 4-9). In diesel exhaust gas, however, the value is about 10% O_2 and in direct injection gasoline engines the figure is about 7-8% O_2.

The inventor has found that in such lean burn exhaust gas compositions, Pt and not Rh is the most effective LNC. This is evidenced by the enclosed declaration of Dr. Stephen Poulston.

An advantage of Pt over Rh as a LNC in treating NO in lean burn exhaust gases is associated with the fact that exhaust gas temperatures of lean burn engines are significantly lower than those from stoichiometrically-operated gasoline engines. Exhaust gas temperatures from diesel engines for passenger cars are up to about 500°C and from gasoline direct injection engines the temperatures are up to about 800°C. Exhaust gases from stoichiometrically-operated gasoline engines can reach about 1100°C.

The declaration confirms that peak NOx conversion for a Pt LNC is about 180°C whereas the peak NOx conversion for a rhodium LNC is about 375°C. Furthermore, one of ordinary skill would understand that the hydrocarbon "light off" temperature for a catalyst, i.e. the temperature at which the catalyst catalyses

the oxidation of hydrocarbon with at least 50% efficiency, generally corresponds to the peak NOx conversion temperature for the catalyst.

These facts are particularly important in the treatment of lean burn exhaust gases because diesel engine exhaust gas temperatures are often lower than 300°C over a test cycle for compliance with an emission control system with relevant emissions legislation. To show this point, the applicant is enclosing PCT Publication No. WO 96/39244 which shows at Figure 2 that, for much of the time during an FTP test cycle, the gas temperature at the inlet to the monolith is between 150 and 200°C. Accordingly, the use of an emission control system comprising a Rh-based LNC should emit more NOx over a legislative test cycle than an emission control system comprising a Pt-based LNC.

As described in the application, the inventor has found that, counter intuitively, a <u>lower</u> loading of Pt actually <u>increases</u> the selectivity of a LNC to catalyze the reduction of NO in lean burn exhaust gas by hydrocarbon, carbon monoxide and hydrogen over oxidation of these reductants by oxygen. This discovery has been adopted in a system embraced by the present claims.

Since Schlatter teaches away from using Pt as a LNC in treating NO in lean exhaust gases from internal combustion engines, there is no suggestion or motivation in Schlatter to modify the reference. Furthermore, it could not have been predicted from Schlatter that Pt would be a better LNC than Rh for treating NO from lean burn exhaust gas. In fact, Schlatter teaches away from such a conclusion for the reasons set forth above. Accordingly, there was no reasonable expectation that the implementation of the claimed invention would be successful, which is required for a *prima facie* showing of obviousness. Finally, Schlatter does not teach or suggest the newly-recited claim limitation to a Pt loading of ≤ $30g/ft^3$.

As mentioned above, Claims 1 and 4-7 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Chen et al. The applicant submits that the invention, as claimed by claims 9-33 is patentable over Chen. In particular, Chen does not describe a lean burn engine comprising an emission control system. The emission control system in Chen is for treating vent gases derived from industrial

processes including volatile organic compounds such as halogenated and non-halogenated carbonaceous compounds and carbon monoxide (see column 2, lines 41-68 and column 12, line 48-column 13, line 8). There is no contemplation in Chen that the first catalyst by a lean NOx catalyst. See, for example, column 3, lines 1-12. Instead, Chen is directed to differentiating the types of supports (low acidity versus high acidity) to effect a differentiation in removal of non-halogenated carbonaceous compounds and halogenated carbonaceous compounds. See abstract, column 7, lines 24-57, and column 14, lines 7-10.

In view of the foregoing, the applicant respectfully requests allowance of the pending claims of this application.

Respectfully Submitted,

Christopher R. Lewis, Reg. No. 36,201
Attorney for Applicant

CRL:aw

Enclosures:
- Version with markings to show changes made;
- Declaration by Stephen Poulston; and
- PCT Publication No. 96/39244

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P.O. Box 980
Valley Forge, PA 19482-0980
(610) 407-0700

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

CLAIMS:

Claims 1-8 have been canceled.

Claims 9-33 have been added.